

TO: Eric Friedman, Director of the State Sustainability Program
FROM: Amy Dain, Rappaport Summer Intern
DATE: August 15, 2002
RE: GHG INVENTORY

This memo represents a road map for creating an annual greenhouse gas inventory for Massachusetts state agencies. I will address the key sources of emissions, methods for obtaining the relevant data and information, and conversion factors needed to translate raw data into the associated emissions.

My recommendations are largely based on the *Greenhouse Gas Protocol* produced by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The *Protocol* defines three “scopes” of greenhouse gases for reporting purposes.

RECOMMENDATIONS:

I recommend that we track and quantify:

Scope 1. Direct GHG emissions from sources owned or controlled by state agencies. In this category, I recommend tracking:

- Fleet fuel use (gasoline, diesel purchased through the state fleet’s fuel card contract),
- Bulk purchases of fuel (gasoline, propane, natural gas) for facility heating, equipment, machinery, etc.

HFC leakage from air conditioning and refrigeration systems is also a likely source of direct emissions, but its measurement is not feasible at this time.

Scope 2. Indirect GHG emissions from purchased electricity and steam. The sources of these emissions are not owned by the state, but the state exerts some control over emissions levels through its activities and policy decisions. I recommend tracking:

- Electricity purchases,
- Steam purchases.

I recommend that we identify, *without quantifying*:

Scope 3. Other indirect GHG emissions that are a consequence of the activities of the reporting agencies but occur from sources owned or controlled by an outside entity. Inadequate means of measuring emissions from these sources is a primary barrier to their inclusion in the inventory. Examples of indirect sources include:

- Energy use in leased office buildings,
- Business travel in personal vehicles,
- Business air travel,
- Employee commuting,
- Solid waste decomposition and incineration,
- Purchased goods and materials that generated emissions during their mining or processing phases,
- Contract services including construction, grounds maintenance and human services,
- Resident travel to access state services.

BACKGROUND: CLIMATE CHANGE & GHG EMISSIONS:

How are greenhouse gases causing global climate change?

A blanket of “greenhouse gases” (water vapor, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) in the earth’s atmosphere absorbs solar radiation and helps warm the planet to a livable temperature range. Human activities including the burning of fossil fuels (coal, oil, and natural gas) for electricity, heating, and transportation, among other things, have contributed to a nearly 30-percent increase in atmospheric concentrations of CO₂ and a doubling of CH₄ concentrations since the pre-industrial period. The buildup of greenhouse gases in the atmosphere has begun to cause global warming and may lead to major environmental changes such as rising sea levels, the spread of infectious diseases, loss in biological diversity, and agricultural shifts.

Why a GHG inventory for state executive agencies?

Many activities of state agencies, including energy use in buildings, vehicle travel, and equipment operation, use fossil fuels and consequently emit GHGs. Conducting an inventory of these activities is the first step in the process of understanding, managing and reducing GHG emissions. The inventory establishes a foundation for setting goals and targets; provides a baseline to measure progress; identifies opportunities for GHG reductions; and serves as a tool for communicating with stakeholders. In addition to addressing global climate change, efforts to reduce greenhouse gas emissions may yield a range of environmental and social benefits such as reduced energy costs, improved compliance with clean air standards, and reduced dependence on foreign oil.

CRITERIA AND BOUNDARIES:

The annual inventory, at a minimum, should focus on state executive agencies. Additional efforts may be made to review other state institutions including universities, hospitals, offices of district attorneys, the courts, and quasi-public agencies such as MWRA, MassPort, MBTA, and the Turnpike Authority. Since some of these institutions have contracts with the central purchasing and facility management offices of the state, the data we collect will not be strictly limited to executive offices.

My recommendations are largely based on the three scopes outlined in the *WRI Greenhouse Gas Protocol*, as well as consideration of the following questions:

- Control: Are state agencies in a position to control the emissions?
- Ownership: Who owns the source of the emissions?
- Materiality: Is the magnitude of emissions from a given source significant?
- Measurement potential: Can we secure accurate data for a given source?
- Transparency: Are the criteria easy to understand and comparable to other inventories’ criteria?

With many entities using the *Greenhouse Gas Protocol* as guidance for their inventories, following the *Protocol* will make our inventory more comparable to others.

RELEVANT AGENCIES FOR DATA COLLECTION:

I recommend working with the following agencies to compile data for scope 1 and scope 2 sources:

Operational Services Division (OSD): OSD establishes contracts for goods and services and provides specific operational services such as vehicle management. With relevance to the GHG inventory, OSD manages statewide contracts to purchase fuel oil, propane, and gasoline, and through its Office of Vehicle Management (OVM), OSD oversees the contract for purchasing gasoline for the state fleet of vehicles.

Division of Capital Asset Management (DCAM): DCAM provides services to state agencies in fields of public building design, construction and real estate. DCAM maintains information on 85,000,000 gross square feet of structures the Commonwealth owns including office buildings, university campuses, hospitals, skating rinks, etc. DCAM also reports on the 7,000,000 square feet of space the Commonwealth leases from the private sector.

In addition, I recommend surveying state executive offices directly to learn about relevant changes in scope 3 sources.

SPECIFIC SOURCES TO MEASURE:

I recommend quantifying the scope 1 and scope 2 sources listed below. Recognizing that scope 3 sources also contribute significantly to total GHG emissions, I recommend identifying scope 3 sources and highlighting qualitative progress towards their reduction.

Scope 1 (Direct emissions) data collection:

Gasoline and other fuels purchased for fleet use: The Office of Vehicle Management (OVM), under the Operational Services Division (OSD), manages a contract with PHH Vehicle Management Services for a fuel credit card that is accepted by 2,500 fuel stations in Massachusetts and surrounding states to purchase gasoline, diesel, and alternative fuels for the approximately 8,000 vehicles in the state fleet. With data provided by the PHH contract, we can determine the total gallons of gasoline and diesel used in state fleet vehicles.

Bulk purchases of gasoline, propane, diesel, and natural gas: OSD manages contracts for bulk purchases of gasoline, propane, diesel, natural gas and CNG used for heating, hot water, equipment, machinery, etc. OSD and DCAM can help quantify those purchases.

Issue 1: Purchases in a given year may not strictly represent use during that year. We may assume, however, that the state does not purchase energy inventory for significantly more than a given year's use within a year.

Issue 2: Agencies may purchase fuels independent of the central purchasing by OSD. It would be difficult to track smaller purchases, and they may not be significant.

HFC leakage from air conditioning systems: The leakage of hydrofluorocarbons (HFC) from air conditioning systems is a likely source of state GHG emissions. Emitted in small quantities, HFCs are powerful greenhouse gases with global warming potentials ranging from 140 to 117,000 times the global warming potential of CO₂. Due to the difficulty of measuring HFC leakages, I recommend not quantifying them, but instead underscoring in the inventory the importance of proper AC maintenance as well as containment and recycling of HFCs in accordance with federal regulations.

Scope 2 (Indirect emissions of electricity, steam) data collection:

While agencies are not directly responsible for these emissions, they can exert control over emissions by reducing electricity use, investing in energy efficient technologies, purchasing renewable energy, and installing distributed generation systems. Scope 2 facilitates the transparent accounting of such choices.

Electricity purchases: I recommend working with DCAM and OSD to compile data on purchases of kilowatt-hours of electricity used in state facilities and on state properties. In a 2002 RFR for the purchase of electricity, OSD estimated that the Executive branch consumes 200,000,000 KWh of electricity annually. This would be associated with 98,000 tons of carbon emissions.

Steam purchases: DCAM and OSD can also help to compile data on mega-pounds of steam purchased for heating and other processes. Steam is produced in boilers fueled by natural gas and No. 6 and No. 2 fuel oils, and is then piped into state facilities.

Scope 3 (Other indirect emissions) identification of sources:

Tracking emissions that occur at sources not owned by the state poses a particular challenge as data can be difficult to obtain and accurate conversion factors are not available in every case. In the future, we may be able to create tools for collecting information on energy use in leased office buildings, business travel, and commuting levels – activities for which conversion factors exist.

Energy use at leased office buildings: While the state owns 85,000,000 square feet of facility space, it leases 7,000,000 square feet, which constitutes 7.6% of total facility use. Electricity and heating of leased facilities do contribute to GHG emissions, but their inclusion within rental fees makes data collection a challenge.

Business travel in personal vehicles: With the average car emitting .8 pounds CO₂ per mile, business travel in personal vehicles could be a relevant source of emissions for the state.

Employee commuting: With over 78,000 employees working for the state, employee commuting represents a significant source of emissions. In 1999 the median U.S. commute to work was ten miles, with 78% of U.S. commuters driving themselves to work. Implementing programs such as the federal Commuter Choice could reduce levels of state employee commuting.

Business air travel: While air travel is a major source of world GHG emissions, it represents a smaller portion of state agency emissions. Air travel is CO₂ intensive: for a 300-mile flight, 200 pounds of carbon are emitted per passenger.

Solid waste disposal and recycling: Decomposition of organic waste in municipal solid waste landfills results in methane emissions; incineration generates CO₂ emissions. In addition, transportation of the solid waste generates carbon emissions. While generating significantly less GHG than incineration and landfilling, the process of recycling (sorting, transporting and manufacturing disposed materials into usable products) also causes emissions.

Purchase of GHG intensive products: This item includes building materials, asphalt, cement, paper, and other products whose production, mining or harvesting processes emit GHGs.

Contract services: Many services under state contract, such as construction projects, maintenance of buildings and grounds, and human service programs, represent sources of GHG emissions.

Resident travel to access state services: GHG emissions from resident vehicle travel to access state services can be minimized through appropriate facility location and web-based services.

CONVERSION FACTORS:

The table lists greenhouse gas conversion factors for translating energy use data into emissions.
Note: One short ton = 2000 pounds = 0.9072 metric tons.

Fuel Type	Amount/ Unit	Pounds CO ₂	Short Tons CO ₂	Pounds CO ₂ per Million Btu
Gasoline	1 Gallon	19.56	0.00978	156.43
Distillate Fuel (#1,2,4, Diesel)	1 Gallon	22.38	0.011175	161.39
Residual Fuel (#5,6)	1 Gallon	26.03	0.013015	173.91
Natural Gas	1000 ft ³	120.59	0.060295	117.080
Propane	1 Gallon	12.67	0.0063345	139.178
Electricity (NE Region)*	1 KWh	0.98	0.00049	
Steam (for heat)	1000 Pounds	579	.289	

*New England regional average chosen because the electricity *purchased and consumed* in Massachusetts is not necessarily all *produced* in Massachusetts.

Factor sources: Fuel conversion factors are from the Energy Information Administration (EIA), U.S. Department of Energy (www.eia.doe.gov/oiaf/1605/factors.html). The electricity factor is from EIA's 2002 report, "Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation, 1998 –2000," (www.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/e-supdoc.pdf). The steam factor is from "Tufts University's Greenhouse Gas Emissions Inventory for 1990 and 1998", (www.tufts.edu/tie/tci).

Car equivalents: To determine the number of cars taken off the road for one year that would reduce CO₂ emissions by the same amount as a given strategy, use the following equation:
(Lbs. CO₂) X (.0511 gallons gasoline/lbs. CO₂) X (20.4 mpg) / (12,500 miles/car-year)

The average fuel economy (20.4 miles per gallon) is from EPA's 2001 report "Light-Duty Automotive Fuel Economy Trends, 1975 –2001" (www.epa.gov/otaq/cert/mpg/fetrends/r01008.pdf). The average annual miles driven per vehicle (12,500) is from the U.S. Department of Transportation's National Personal Transportation Survey, (www.cta.ornl.gov/npts/1990/fat/tab3_26.pdf).

NEXT STEPS:

1. **Collect data:** Meet with DCAM & OSD to compile the data; convert data into emissions.
2. **Survey agencies directly:** Design a survey for State Sustainability Council members to report (qualitatively) on agency-based sources of GHG emissions beyond the ones tracked and quantified by OSD and DCAM. This survey will also serve as a tool for tracking performance indicators that benchmark accomplishments of state sustainability.
3. **Write report:** Post report on the web and share it with stakeholders.
4. **Create reduction strategy:** With the inventory as a guide, work with the State Sustainability Council to create a strategy for reducing GHG emissions at agencies.
5. **Explore options for obtaining scope 3 data:** Consider methods of obtaining scope 3 data such as (A) including provisions in leasing contracts for reporting on energy use, (B) conducting a survey of employee commuting patterns, (C) creating a system for tracking business travel in personal vehicles and (D) requiring state contractors to report on their GHG emissions.
6. **Assist non-Executive public organizations in creating inventories:** Work with universities, hospitals, and quasi-public agencies to develop their own GHG accounting.

RESEARCH SOURCES:

The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI), October 2001, <http://www.ghgprotocol.org/standard/ghg.pdf>

An Overview of Greenhouse Gas Emissions Inventory Issues, Pew Center on Global Climate Change, August 2000, <http://www.pewclimate.org/projects/greenhouse.cfm>

EPA's website on global warming: <http://www.epa.gov/globalwarming/>